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Grimes, Paul W. and Marlin, James and Niss, James

Western Illinois University

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STUDENT LEARNING AND COMPUTER MANAGED INSTRUCTION
IN THE PRINCIPLES OF ECONOMICS COURSE

Paul W. Grimes *

James Marlin **

James Niss ***

I. INTRODUCTION

In 1978, the Department of Economics at Western Illinois University initiated a self-paced, multi-media, micro computer-managed instructional (CMI) system designated the Advanced Learning System (ALS). The ALS has been utilized in the teaching of the sophomore level Principles of Economics I and II courses with noted success (6;7). The subject matter of the courses taught in the ALS is similar in nature to the basic economics courses taught in colleges across the nation. The first course (Econ 231 Principles of Economics I) deals with the concepts of national income, inflation, employment and other topics related to the national economy. The second course (Econ 232 Principles of Economics II) is concerned with the theory of the firm and household and their inter-relationship.

The structure of the ALS is rooted in the theory that students learn more when testing is over short blocks of instruction and occurs more frequently (3). Course material for students enrolled in an ALS Principles class is divided into small units of study with each unit covering a limited amount of related topics. Within each unit of material students are given specific objectives covering the important concepts they are expected to learn. Comprehensive student guidebooks have been developed to present students with the learning objectives and to introduce them to the media available to learn each objective (4;5). A variety of instruments are used to teach the objectives in each unit. In a laboratory setting, students have access to a variety of textbooks, videotape programs, programmed workbooks, audiotape cassette workbooks, and discussion sessions with graduate students and faculty. For each unit, students are given a list of assignments that will help them master the learning objectives for that unit. When the student believes he/she has accomplished the objectives, he/she tests on the computer. A flow chart of ALS student learning activity is shown in Figure I.

All testing in the ALS is completed on a computer terminal. Tests are generated from a test bank of over 1,500 questions stored on disks. Each question is keyed to specific learning objectives and unit tests are generated randomly based on a weighted formula which depends on the number of questions assigned to each objective. When students take tests, they sign on to the computer and it generates a unit test specifically for each student. As soon as a student completes a test, the computer scores and records the student's performance. Questions missed are reviewed immediately at the terminal and the student given instructions for study. The students are informed of not only what was missed, but why their responses were incorrect.

Students must achieve a score of 85%, a level determined to be consistent with mastery of the material (6;7), on a unit test to satisfactorily complete that unit. If a grade of 85% is not received, the student is required to retake the test. Students are given three tries on the computer to master the material and achieve the needed score. If the student is not successful after the third attempt he/she is required to take an oral exam. Thus, students are forced to master the material before moving on to the next unit. This is particularly helpful in economics since the material is serial in nature. That is, students need to know the material in Unit 1 before they can comprehend the material in Unit 2. Grading in the ALS courses is based upon the number of units completed, a term paper on economic policy, and a final exam. In addition to administering the testing procedures, the ALS computer is programmed to record and track each student's progress throughout the course. In essence, by employing computer-management instruction in the ALS courses faculty are have more time to teach.

* Assistant Professor, Department of Economics, Western Illinois University, Macomb, IL 61455

** Professor and Chairman, Department of Economics, Appalachian State University, Boone, NC 28608

*** Professor of Economics and Director of Faculty Development, Western Illinois University, Macomb, IL 61455.

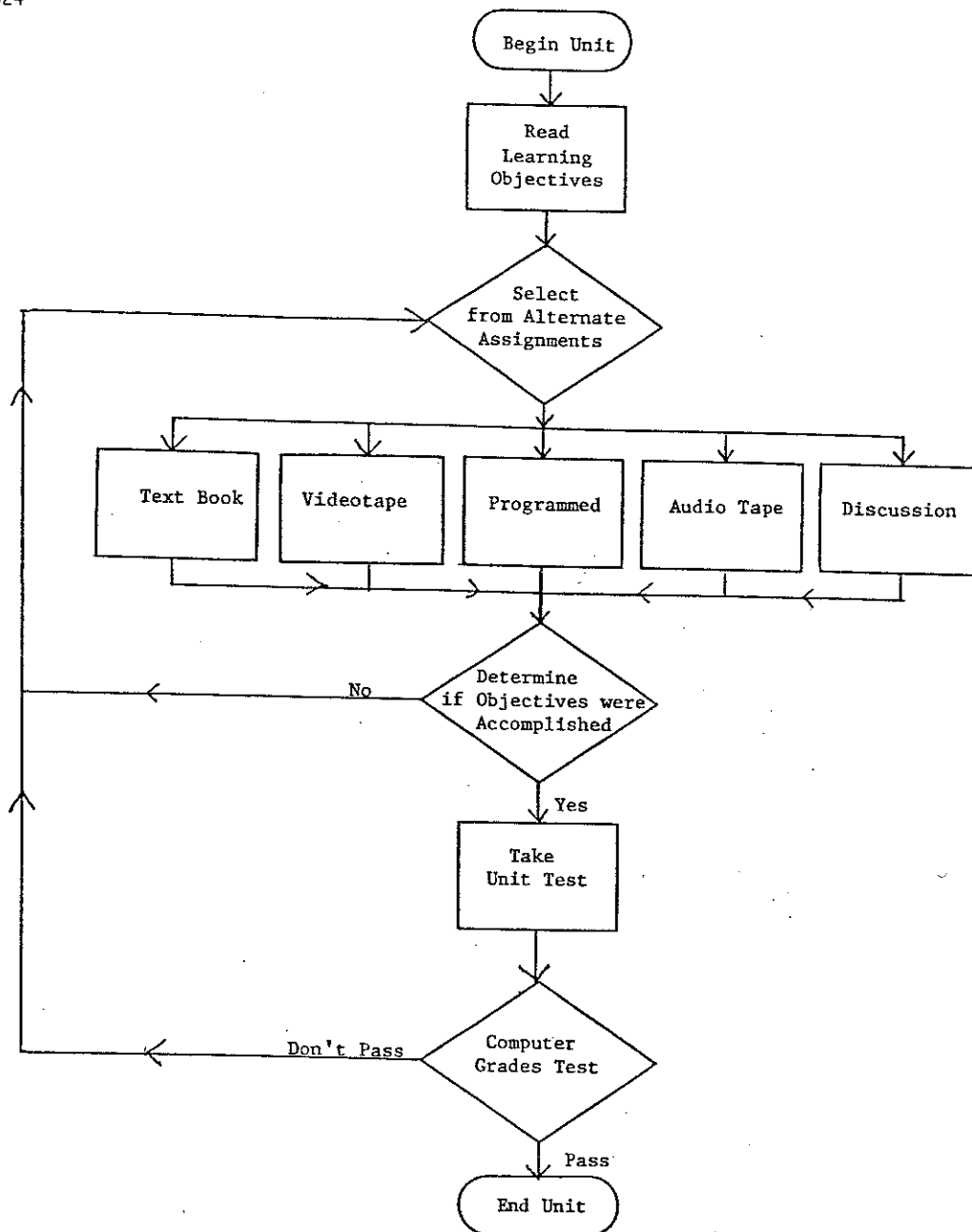


FIGURE I

The ALS format has proven popular with students given that two to three hundred students enroll in ALS sections each academic year. Most instructors utilizing the ALS format for their courses have been pleased concerning student performance on standardized tests. It has been shown in a previous study that most groups of students completing an ALS Principles course score at or above the level for like groups of students exposed to Principles in a traditional lecture classroom setting (6).

While the ALS approach to teaching Principles of Economics has proven successful in most respects, it has not gone uncriticized. Perhaps the greatest drawback as perceived by the faculty in the ALS format is the relatively large number of students that do not complete the course requirements by the end of each semester. Historically, twenty-five to thirty percent of each class receive grades of Incomplete. This of course is expected given the conflict between the nature of a self-paced course of instruction and the institutional constraints imposed by the academic calendar. While many students may need more than the standard sixteen week semester to master a first course in Economics, it has become apparent that a large number of Incompletes are due simply to student procrastination.

A second, more philosophical, criticism of the ALS format involves how student grades are determined. Under the ALS system students earn higher grades based upon the completion of additional work. It is thus argued that grades determined in such a fashion place a greater weight on the quantity of work performed rather than upon the quality of work. While all students are required to perform up to some predetermined "mastery" level, course grades do not reflect deviations in the quality of student work above that level.

Based upon these criticisms of the ALS, a new Structured ALS format was developed to integrate the most successful aspects of lab learning environment with a more traditional classroom setting. To control for student procrastination, students in a Structured ALS course are instructor-paced rather than self-paced. The instructor chooses which units of instruction will be covered during the semester and sets a deadline for completion of each unit. Thus, all students are expected to complete the same amount of material at the same time. In addition to the learning material available in the lab, students are also required to meet together in class one hour each week where problems and questions are addressed by the instructor. Testing for each unit of study is still handled on the computer in the same manner as described above. Since each student is covering the same amount of material, grades are based on student performance concerning unit examinations. While students are still given three attempts to achieve an 85% (our arbitrary mastery level) the score on each attempt is used for grading purposes. In practice, each examination attempt is averaged to arrive at a "unit score." Students thus have an incentive to take each attempt more seriously. Unit scores are then averaged with a comprehensive final exam and any other work assigned by the instructor for purposes of determining a final grade. The exact grading scale is left up to the discretion of the instructor.

II. METHODOLOGY

During the Spring 1985 semester approximately 150 students enrolled in Structured ALS classes. To test the effectiveness of the new course format these students were pre- and post-tested using the standardized Test of Economic Literacy (TEL) provided by the Joint Council on Economic Education. Roughly an equal number of students in traditional lecture classes were also tested to serve as a control group (all students used in our experimental groups were enrolled in Principles of Economics II). Demographic and academic characteristics were collected for each student. The mean values of relevant variables for each group are reflected in Table I. The t-values in Table I reflect a test of the null hypothesis that the mean values of the variables are equal between the two groups. It is obvious the two groups are very similar and significant differences in PreTest and PostTest scores do not exist. No significant difference in learning is found between the two groups. We must conclude that the two groups exited the Principles of Economics experience after acquiring about the same quantity of economic understanding.

Given the apparent similarities of the two groups, a regression model of student learning, captured by student performance on the post-course exam, was estimated for both the Structured ALS and traditional student groups. Using ordinary least squares, a model of the following form was employed:

$$\text{PostTest} = a + b_1(\text{PreTest}) + b_2(\text{ACT}) + b_3(\text{GPA}) + b_4(\text{College}) + b_5(\text{Hours}) \\ + b_6(\text{Age}) + b_7(\text{Sex}) + e$$

Where:

PostTest = TEL score achieved at end of semester

PreTest = TEL score achieved at beginning of semester

ACT = Composite score on standardized ACT exam

GPA = Students' college grade point average (4.0 scale)

College = 1 if student is Business major, 0 otherwise

Hours = Number of college hours passed previously

Age = Age of student in years

Sex = 1 if female, 0 if male

e = random disturbance term

The model closely follows the economic education literature concerning differences in student learning performance under varying course format conditions (1). The PreTest variable is included to control for the students' stock of economic knowledge coming into

TABLE I

MEAN VALUES OF PERFORMANCE VARIABLES

VARIABLE	STRUCTURED ALS	TRADITIONAL	t-VALUE*
PreTest	30.14	31.54	- .92
PostTest	31.85	30.58	.85
ACT	20.66	19.62	1.55
GPA	2.89	2.75	1.16
N	62	65	

*Testing Null Hypothesis: Means are equal between groups

TABLE II

DETERMINANTS OF POST EXAM SCORE

Independent Variable	STRUCTURED ALS	TRADITIONAL	POOLED
Constant	-18.02 (-1.55)	19.28* (1.63)	5.07 (.60)
PreTest	.43*** (4.19)	.80*** (11.88)	.72*** (13.24)
ACT	.32*** (2.69)	-.02 (-.11)	.13 (1.11)
GPA	2.70*** (2.81)	-.88 (-.63)	.49 (.58)
College	-.81 (-.67)	-2.09 (-1.27)	-1.86*** (-1.77)
Hours	.01 (.46)	.07 (1.34)	.04 (1.34)
Age	1.12*** (2.08)	-.61 (-1.09)	.01 (.02)
Sex	-3.49*** (-2.80)	-2.05 (-1.43)	-2.64*** (-2.77)
F	17.94	24.98	39.41
R ²	.70	.75	.70

* Significant at .10 level

** Significant at .05 level

*** Significant at .01 level

the course. Thus, a strong positive relationship is expected. The ACT and GPA scores appear in the equation to respectively control for the students' innate abilities and their capability to apply their skills in a university setting. Therefore, positive regression coefficients are also expected for the ACT and GPA variables. The dummy variable for College major is included to capture any motivational differences between student groups. Business majors are required to take the Principles of Economic sequence and therefore may have a stronger motivation to perform well in their chosen area. If this hypothesis is correct, we would expect to estimate a positive coefficient for the College variable. The Hours variable is included to test the assumption that those with a longer college experience may have "learned how to learn" to a greater extent than those with limited college hours of classwork. The continuous variable for Age and the categorical variable for Sex are included to capture any differences in learning across these demographic groups and to assure the model is correctly specified.

III. RESULTS

The regression results for students in the Structured ALS course and the traditional lecture course are reported in the first two columns of Table II. Based upon the R^2 values the model appears to explain a significant portion of the variation in the PostTest scores for each course format. However, it is also apparent that the estimated coefficients in the two equations are quite different. In order to test whether the two estimated equations are statistically different, the datasets were pooled and a Chow test was performed (2). The pooled regression model equation is reported as the third column in Table II. The F-statistic derived from the Chow procedure was calculated to be 2.48 with [8, 112] degrees of freedom. Thus, the original two equations are statistically different from each other at the .05 level of confidence. Based on this finding, we conclude that the learning function significantly varies between the two class formats with different variables assuming different weights of importance.

Examination of the regression results concerning the PreTest coefficients indicate that a student's previous stock of economic knowledge is a better indicator of end of course performance in the traditional class setting than in the Structured ALS format. Low PreTest scores are therefore not as important to end of course performance in the structured lab setting. However, a student's ACT and GPA records appear to be of greater importance in the lab environment than in the traditional classroom setting for our samples. This may reflect the greater importance of self-motivation required by students to actively pursue the different modes of learning available in the laboratory.

The regression coefficients estimated for the College major variable do not indicate a statistically significant difference between Business and non-Business majors when the samples are considered separately. It is interesting to note when the samples are pooled across course formats a highly significant and negative coefficient is uncovered for the College variable. This suggests that perhaps those students not required to take Principles, but do so under their own personal motivations, learn more over the length of the semester as measured by PostTest scores. The estimated coefficients for the college Hours variable takes on the expected positive sign, but in all cases is statistically insignificant.

The Age and Sex estimates offer clues to the basic demographic characteristics of students who perform well under the two types of class formats. While the statistically insignificant coefficients in the traditional class format equation suggest that Age and Sex do not play a strong role in the determination of PostTest scores in the traditional classroom setting, both the Age and Sex coefficients are significant in the Structured ALS course equation. According to the results, each additional year in age will add 1.12 points to a student's PostTest score. The negative Sex coefficient indicates that male students score significantly better than female students when both are exposed to the Structured ALS course format. Such results are not unexpected and can be justified by appealing intuitive hypotheses. Older students may possess the personal initiative and ability to work independently within the laboratory setting that may not be fully developed in younger students. Likewise, cultural and societal influences may endow male students, to a greater extent than female students, with the skills necessary to manipulate the mechanical and computerized learning equipment (video machines, computer terminals, etc.) used in the ALS lab. A more indepth analysis of the learning process is needed to test such hypotheses.

IV. CONCLUSION

Our statistical results suggest that students in the Structured ALS format classes score about the same on PostTest examinations as students in a traditional lecture course. Further, the regression model indicates that students with relatively high ACT and GPA scores will tend to learn more in the structured lab setting than like students in the regular classroom. Also we have found that older students and male students will score better relative to others taking the Structured ALS course.

The results as presented here have encouraged the Department of Economics at Western Illinois University to continue its experimentation with its Structured ALS approach in teaching the first two Principles of Economics courses. Student response to the new

Structured format has also been encouraging. In a survey of the classes representing the samples presented above, 71% of the students responded that they would recommend fellow students to take the course.

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